Trap levels in persistent phosphors for bio-imaging

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1. Introduction

Since more than two decades, efficient and long afterglow persistent luminescent materials are available for emergency signalization, road markings and toys. Available emission colors range from violet to red, but longer wavelengths are hard to achieve with rare earth dopants. While near-infrared emitting phosphors could be useful in night vision or security applications, they are especially promising for medical imaging. Next to Mn^{4+} [1], Cr^{3+} is an excellent dopant for emission in the so-called first optical window for bio-imaging, from 650 to 950 nm [2]. In this work, the spinel $LiGa_5O_8$ is used as the host for Cr^{3+} ions, leading to a combination of broadband and narrowband emission around 720 nm [3,4]. Even without any co-dopants, afterglow can be measured for several hours.

2. Results

A combination of the initial rise and T_{stop}-T_{max} methods was shown to be an efficient way to retrieve the distribution of trap depths in the persistent phosphor $LiGa_5O_8:Cr^{3+}$. A large data set was produced by making a series of TL (thermoluminescence) measurements at different excitation temperatures. All these data were fitted simultaneously using a single set of trapping parameters. The traps were found to consist of three broad Gaussian trap distributions, see figure 1 [5]. This single set of model parameters allowed to accurately describe the experimental afterglow characteristics of the phosphor, as shown in figure 2. In addition, the parameters can be used to predict other effects of fading and the temperature dependence of the afterglow, which was measured independently.

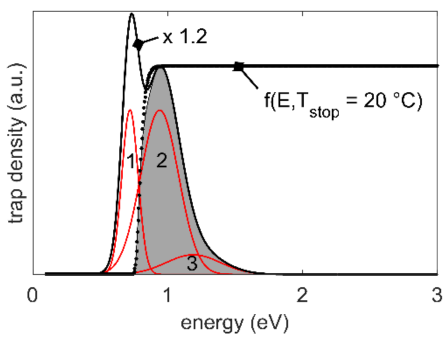

Fig. 1: Trap distribution calculated from the TL data.
The expected trap filling factor at 20°C is also indicated.

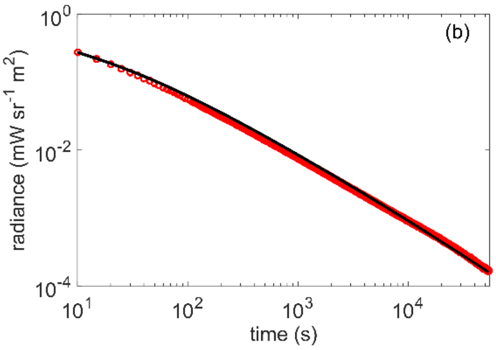

Fig. 2: Experimental (markers) and predicted afterglow
(full line), based on the calculated trap distributions.

3. References

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